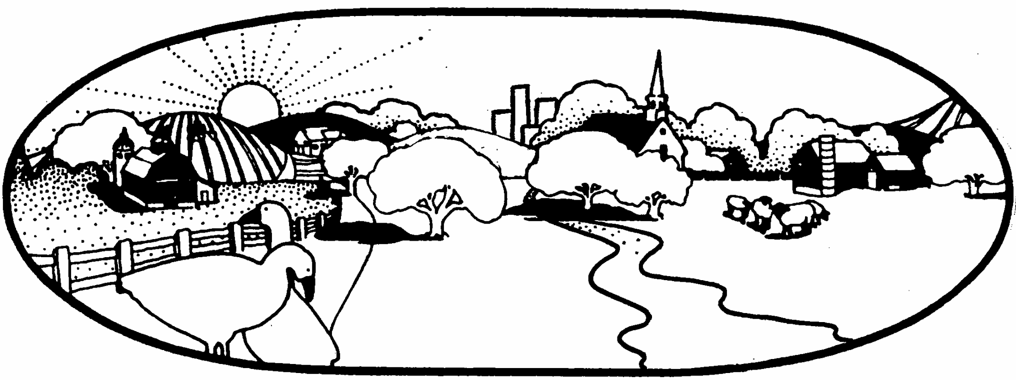
Final Report

Enchanted Hills Watershed Evaluation

Submitted to:

Enchanted Hills Watershed Task Force



Submitted by:

Koskiusko County Soil and Water Conservation District
Noble County Soil and Water Conservation District

In cooperation with:

Indiana Department of Natural Resources, Division of Soil Conservation
Natural Resource Conservation Service
Koskiusko County Surveyor
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I. INTRODUCTION

The Enchanted Hills Homeowners Association contacted the Kosciusko and Noble County Soil and Water Conservation Districts (SWCD) in August 1993. The homeowners were primarily concerned about their channels filling with sediment, which they thought was eroding from cropland fields. Barry Bortner, Natural Resource Conservation Service Noble County made an on-site visit and completed a preliminary report on his findings. The report recommended that the Enchanted Hills Homeowners Association submit a formal request for technical assistance to the Kosciusko and Noble County SWCD's.

Betty Knapp and David Culp of the Wawasee Area Conservancy Foundation contacted the Noble County SWCD in April 1994. They indicated an interest to provide the necessary leadership to move the project forward. The Conservancy agreed to coordinate activities with the Homeowners Association. They agreed to form a Task Force to address all of the resource concerns in the watershed and provide leadership. The Task Force was formed, and three meetings have been held. The Task Force includes members with technical backgrounds, homeowners around the lake and channels, farmers, the Conservancy, and the SWCD's. The following report has been prepared to assist the Task Force in making land-use decisions in order to maintain and improve a healthy watershed environment.

A. Description of the Watershed

The Enchanted Hills Watershed is located in Kosciusko and Noble Counties, Indiana. The Enchanted Hills Watershed is a part of the 23,318 acre Lake Wawasee watershed. The watershed is located on the east side of Lake Wawasee (Figure 1).

The Enchanted Hills watershed area consists of three sub-basins. The largest sub-basin is the Dillon Creek, the southern tributary, consisting of approximately 1650 acres. The second largest sub-basin, which is located immediately north of Dillion Creek, is Launer Ditch, consisting of approximately 1325 acres. North of the Launer Ditch sub-basin is the Norris Branch tributary, with its 540 acre watershed.

The total watershed area of the three sub-basins is 3515 acres. Each of the three tributaries outlets into channels within the Enchanted Hills development. See Figure 2 for watershed location.

Of the total watershed area, 68% (2390 acres) is used for the production of agricultural crops, 13% is woodland, and the remaining 19% is miscellaneous (small lots, roads, idle land, town of Cromwell, Enchanted Hills development, railroad, etc.). The percentage and types of land use vary within the three sub-basins.

Most farms are cash grain operations, producing corn and soybeans as the major crops. Some seed corn is produced in localized areas of the watershed.

Approximately 35% of the cropland is currently farmed using the no-till system. The remaining cropland is being chisel/disk tilled, leaving less than 30% residue on the soil surface. Residue levels less than 30% severely limit ability to reduce agricultural runoff.

There is only one significant livestock producer in the watershed. This operation is located adjacent to the open ditch, and has the potential to affect water quality.

Soils in the watershed consist of the Miami-Riddle-Brookston association in the southern portions, and the Homer-Sebewa association in the northern portions of the watershed. The Miami-Riddle-Brookston association consists of soils which are well drained to very poorly drained, nearly level to moderately sloping, and have a moderately fine textured subsoil. Erosion is a hazard on sloping Miami and Riddles soils. Wetness is a limitation on Brookston soils.

The Homer-Sebewa association consists of soils which are poorly drained and very poorly drained, nearly level soils that have a moderately fine textured subsoil, and are moderately deep over sand and gravel. Areas of the Fox-Oshtemo association are mixed in with the Homer-Sebewa. The Fox-Oshtemo soils are well-drained, nearly level to moderately steep soils, that have a moderately coarse texture to moderately fine texture subsoil. These soils are moderately deep over sand and gravel.

Most of the land in the Dillon Creek sub-basin slopes directly toward the open ditches, which explains the quick response in runoff from intense rainfall. The exception to this is about 250 acres that are ponded, and outlet only through tile drains. The most sloping acreage in the watershed is in the Dillon Creek sub-basin, and is located east of State Road 5.

The eastern portion of the Launer Ditch sub-basin is gently rolling, and the western portion is rather flat. The drainage system for the sub-basin consists of a combination of open ditches and tile drains. Runoff does not reach the main tributary as quickly in this sub-basin, compared to the Dillon Creek sub-basin.

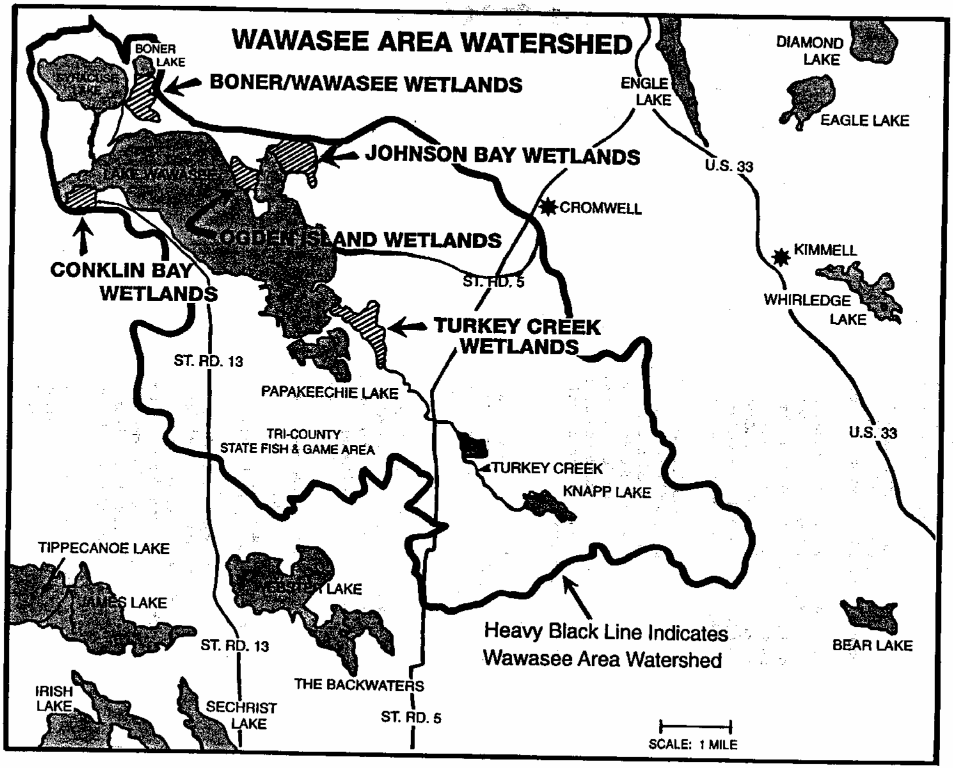
The Norris Branch sub-basin is flat, and runoff is slow compared to the other sub-basins.

B. Nature of the Problem

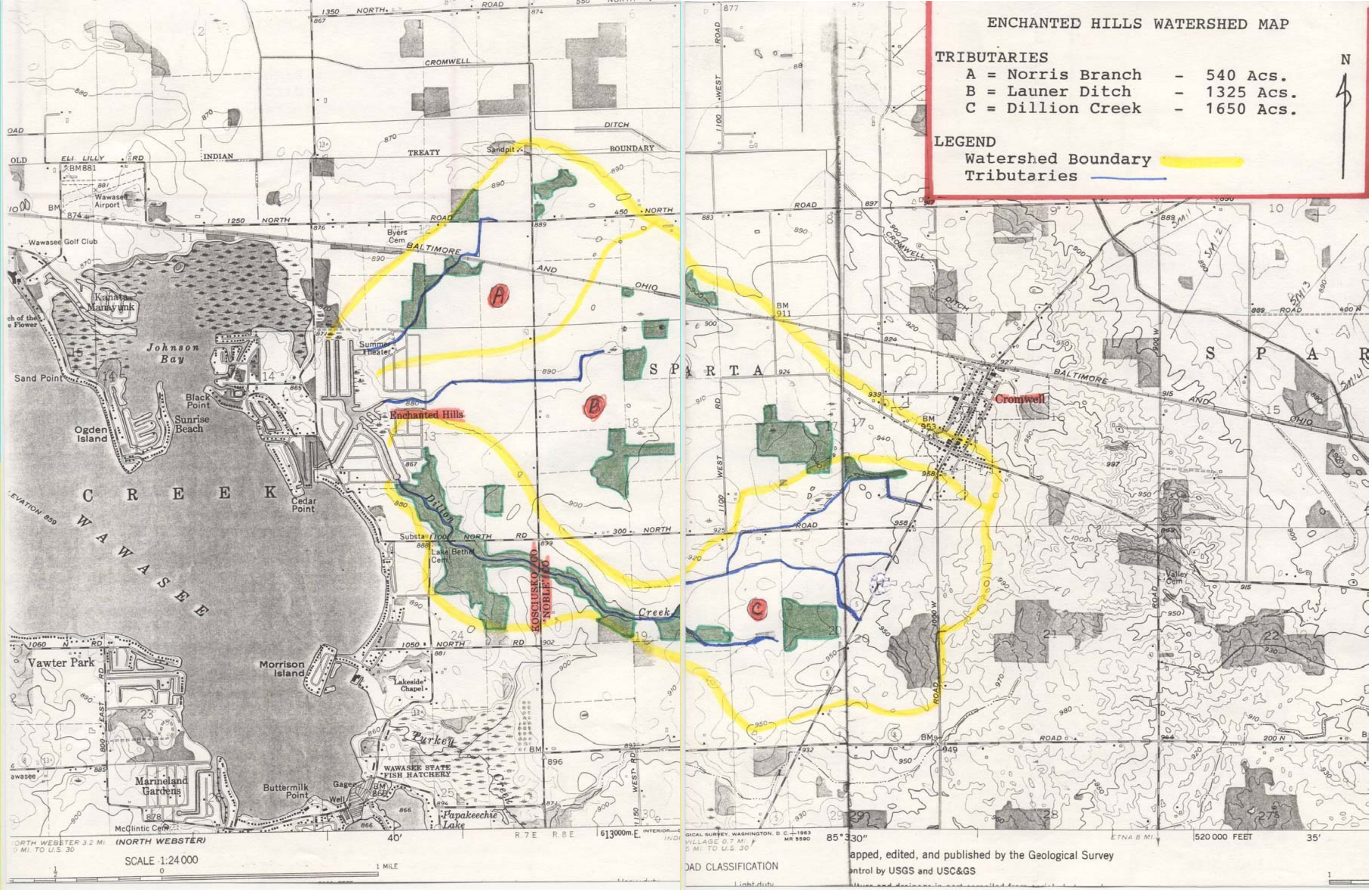
There has been some loss of depth in the channel system located within the Enchanted Hills sub-division. Sedimentation has reduced channel depths from six feet to one or two feet in some areas, especially near the outlet of Dillon Creek. There have been occurrences of noxious aquatic plants. The problems appear to be moving further into the channel system, toward the lake. However, data gathered indicates that the movement is a slow process.

Prior to the current study, the sedimentation in the channel system appeared to be related to sediment loading from the agricultural areas of the watershed. However, significant soil erosion has been observed

FIGURE #1



WAWASEE AREA WATERSHED
BONER LAKE
BONER/WAWASEE WETLANDS
LAKE WAWASEE
JOHNSON BAY WETLANDS
OGDEN ISLAND WETLANDS
CONKLIN BAY WETLANDS
TURKEY CREEK WETLANDS
PAPAKEECHIE LAKE
ST. RD. 13
ST. RD. 5
TRI-COUNTY STATE FISH & GAME AREA
TURKEY CREEK
KNAPP LAKE
CROMWELL
KIMMELL
ENGLE LAKE
DIAMOND LAKE
EAGLE LAKE
U.S. 33
WHIRLEDGE LAKE
TIPPECANOE LAKE
JAMES LAKE
LAKE
THE BACKWATERS
IRISH LAKE
SECHRIST LAKE
BEAR LAKE
Heavy Black Line Indicates Wawasee Area Watershed
SCALE: 1 MILE


ENCHANTED HILLS WATERSHED MAP
TRIBUTARIES
A = Norris Branch - 540 Acs.
B = Launer Ditch - 1325 Acs.
C = Dillion Creek - 1650 Acs.
N
LEGEND
Watershed Boundary
Tributaries
Enchanted Hills
Cromwell
SPARTA
WAWASEE
Johnson Bay
Dillion Creek
SCALE 1:24 000
apped, edited, and published by the Geological Survey
ontrol by USGS and USC&GS

within the tributary channels and the Enchanted Hills development area.

The observed sediment accumulation has impaired the recreational value of some areas within the channel system and the sediment is, to some degree, being flushed into the lake. The degree of erosion, and related sedimentation into the channel system and lake, will likely increase in the future, if best management practices are not applied throughout the watershed.

C. Study Objectives

The Enchanted Hills Watershed Task Force identified the following objectives:

1. Identify the sources of sediment found within the channel system and lake.
2. Assess the quality of the water flowing into the channel system and lake.
3. Recommend watershed best management practices that minimize sediment loading and improve water quality.

In pursuit of these objectives, the following resource concerns were evaluated:

1. Runoff from the rural portion of the watershed.
2. Runoff from the urban portion of the watershed.
3. Stream erosion within the tributaries.
4. Sedimentation levels and sources within the channel system.
5. Water quality testing of runoff flowing into the channel system and lake.

II. WATERSHED REVIEW, EVALUATION, AND RECOMMENDATIONS

A. Rural Watershed Evaluation

A team consisting of Wayne Stanger - Natural Resource Conservation Service Noble County, Barry Bortner - NRCS Noble County, Doug Nusbaum - Indiana Department of Natural Resources Noble County, Rick Duff - NRCS Koskiusko County, and Kent Tracey - IDNR, Lake and River Enhancement, investigated and determined the following for the rural portion of the watershed:

Streambank, ephemeral gully, sheet, and rill erosion are sources of sediment delivered to the channels and lake. The open ditches themselves are contributors of sediment, primarily in the section from County Road 300 N (old state road 8) to 1/2 mile east of County Line Road on the Dillion Creek tributary. The average grade of this section is approximately 0.6%. This will be addressed in a later section.

Most of the active ephemeral gully erosion is occurring in the Launer Ditch and Dillion Creek sub-basins. Gully erosion is occurring at some sites throughout the watershed, where overland flow enters the receiving tributary.

Sheet and rill erosion are occurring throughout the watershed on the gently sloping soils, where little residues remain after planting and/or where intense rotations are followed. The most significant sheet and rill erosion is occurring on approximately 18% of the cropland acreage. Soil loss and movement would normally be considered a moderate problem. However soil loss and movement may be more severe on some cropland, because water runoff and associated sediments and nutrients/pesticides have only a short traveling distance to the tributaries.

There is a potential for pesticides and nutrients to reach the receiving surface and ground water. This potential exists because:

1. Runoff quickly reaches the tributaries, especially in Dillon Creek.

2. Unprotected (non-filtered) surface drainage inlets flow directly into the tributaries.

3. Coarse textured soils exist, with high potential for leaching.

It should be noted that land treatment activities in the Enchanted Hills Watershed have been on-going for a number of years. Severe stream erosion at the mouth of the Launer Ditch was stabilized by action of the joint county drainage boards. Four projects have been implemented to control gully erosion in the upper reaches of the Launer Ditch and Dillon Creek watersheds. Farmers, representing approximately 35% of the cropland acreage, have converted to the no-till system in the past 10-15 years. This has resulted in a minimum 60% reduction in soil movement compared to previous tillage methods .

However, there may be a need to accelerate the land treatment activity to provide further benefits.

In Summary:

Controlling rainfall at the point of impact is the most effective way to reduce soil erosion, and the delivery of related nutrients to receiving waters. Typically, education and agronomic practices are the most effective non-structural means for controlling run-off. Some examples of these methods are:

1. Educating agricultural and non-agricultural landowners in the watershed about the influence they may have on the lake.

2. Offering incentives to farmers to implement practices which will reduce the amount of sediment leaving their fields. For example: conservation tillage, hayland seeding, tree or wildlife cover plantings, critical area seeding, or filter strips.

All rainfall cannot be controlled at the point of impact. Thus, structural practices must be installed to reduce soil erosion where concentrated flow and runoff occur. Some practices more commonly implemented are: grassed waterways, grade stabilization structures, and streambank stabilization.

Table 1 shows the projected practices, their extent, and associated estimated costs for implementation in the watershed. This would be a good tool to use if a land treatment project is to be pursued.

Practice	Extent	Unit Cost	Cost Estimate
1. Vegetative Filter Strips	10,000 LF	.40	$4,000.00
2. Waste Mgmt. System	1 each	5,000.00	5,000.00
3. Grassed Waterways	7,000 LF	3.00	21,000.00
4. Grade Stabilization Structure	7 each	2,500.00	17,500.00
5. Conservation Tillage	1,000 ac	(avg)12.00	36,000.00 (3 yrs)
6. Pesticide and Nutrient Management	1,300 ac	10.00	39,000.00 (3 yrs)
7. Fencing	1,000 LF	1.50	1,500.00
8. Seeding Permanent Pasture	20 acres	120.00	2,400.00
9. Tree Planting	20 acres	350.00	7,000.00
10. Wildlife Habitat Dev.	20 acres	400.00	8,000.00
11. WASCOBs	6 each	1,500.00	9,000.00
12. Cover Crops	350 acres	12.00	12,600.00 (3 yrs)
13. Critical Area Seeding	5 acres	650.00	3,200.00
14. Streambank Stabilization (Combination Rip-Rap & Vegetation)	1,000 LF	10.00	10,000.00
15. Crop Rotation	5.00		
Total Cost Estimate			$176,200.00

Table #1: Land Treatment Projections

B. Urban Watershed Evaluation

Urban runoff concerns were gathered by Mike Massonne, Gwen White, and Kent Tracey, IDNR, Division of Soil Conservation, and Roger Roeske and Wayne Stanger, USDA, Natural Resource Conservation Service.

As in most watersheds, urban development around a lake can impact the water quality of the lake. Some of the problems are: erosion during construction, improper lawn care, malfunctioning septic systems, road runoff, and wetland loss.

Soil erosion on construction sites often results, as it may during many land use changes. Construction is usually associated with progress, and provides some unique engineering challenges for soil erosion control.

The closer a construction or development site is to water, the more likely soil will move from the site and end up as sediment in the lake and associated channels. This is especially true if the soil is bare and rainfall intense. Construction can involve filling a site, dipping out a channel, or landscaping a lawn. It may involve building a house, garage, car port, dock, sea wall, barbecue, gazebo, or driveway. Construction of driveways, patios, houses, and other impermeable surface areas result in quick runoff, with little filtering. Prior to construction, depressional areas and vegetation reduced the speed of runoff and filtered unwanted nutrients, pesticides, and sediments before they reached the lake.

Proper care must be taken during land disturbing activities, to protect the soil. The Enchanted Hills Homeowners Association should develop guidelines to address erosion during these activities. The local city or county may have an ordinance that could be used as a model. The state has a erosion control guidelines for areas over five acres. The SWCD can also assist in this area.

Water quality problems can result if proper lawn care precautions are not taken. If fertilizer is washed into the lake, weeds and algae will feed from the nutrients, encouraging eutrophication. Lawn fertilization rates should be determined through taking a soil test to avoid over application. Buffer strips along the lake shore (approx. 15 to 20 feet) will filter any fertilizer that may wash off in a storm. Proper management of herbicides and insecticides should be followed to avoid run-off. Grass clippings disposed near (or into) the lake may result in additional nutrient loading.

Many homes rely on septic systems that were installed years ago. If the septic system is not properly sized or maintained, the septic effluent can leach into the lake. Fecal coliform testing is recommended in the channels, especially in areas where problems likely exist.

Land use changes affect sediment and nutrient loads. The changes may be to wetlands or idle lands, to residential property or ditches (being re-directed). When natural wetland areas are altered, part of the natural filtering process is removed or changed. The runoff is not filtered as before because the water retention within the pocketed areas is significantly reduced. Thus, more of the runoff reaches the channels quickly. The runoff now takes its nutrients and sediments with it. Some examples of land use changes and their effects on the watershed are: roads near the channel allow salt to wash into the lake. Material may fall from dirty cars or trucks, and eventually wash into the lake. Careful planning can reduce the amount of wetlands that are lost during development. Some of the wetland areas can be enhanced to support wildlife and provide recreation, while still providing filtering and drainage benefits.

Vegetation transition zones are areas along the edge of the lake where no plants grow. Because these areas are often bare, they may contribute to sediment and nutrient loading in the lake. This transition area is difficult to stabilize, because wave action strongly affects these edges. Many times stones or concrete are placed in the non-vegetated areas. A seawall is commonly employed in these areas. The seawall can be used as a dock, and can also serve as a retaining wall for fill when leveling lawns.

To protect and improve the water quality of Enchanted Hills and Lake Wawasee, education programs, planning, and best management practices should be implemented. Educational seminars and field days should be held to address many of the previously mentioned best management practices. The first step is to make all homeowners, developers, etc. aware of potential urban watershed problems and what they can do to help address them. Assistance in planning and implementing programs can be requested through your local SWCD.

C. Tributary Evaluation

The Enchanted Hills Watershed is comprised of three tributaries. They are Dillon Creek, Launer Ditch and Norris Branch. A previous report identified stream erosion as a significant concern, especially on Dillon Creek. Thus, a team consisting of Roger Roeske - Natural Resource Conservation Service Area Engineer; Barry Bortner - Natural Resource Conservation Service Noble County; Rodney Renkenberger - Noble County Surveyor; Dick Kemper - Kosciusko County Surveyor; Gary Franklin, Noble County SWCD and Sam St. Clair, Natural Resource Conservation Service, Kosciusko County, conducted an on-site evaluation. Roger Roeske then prepared a report addressing alternatives to reduce the erosion within the watershed's tributaries.

Dillon Creek's channel is 13,700 feet long. This tributary can be further be divided into five distinct reaches. These reaches starting from the lake and proceeding upstream are:

3000' of 0.3% grade
1500' of 0.6% grade
3800' of 0.5% grade
3000' of 0.3% grade
2400' of 0.8% grade

The optimum channel grade for streams, based on the soils and topography found in Northern Indiana, is 0.3% or less. Grades exceeding 0.3% are considered erosive, and either need protection or reconstruction to reduce the amount of fall. Reducing fall in the tributaries will result in a more stable situation within the channels.

The site evaluation suggested five alternatives for Dillon Creek tributary. Each will be described and briefly discussed:

Alternative #1 - Construction of a sediment basin on the south side of County Road 1100 North in Kosciusko County. If constructed approximately 18 feet high, the pool area behind the dam would be 15 feet deep and store 240 acre feet of water over a 40 acre area. Drawdown times can vary from one day to one week depending on the size of the outlet pipe (36" CMP to 18" CMP). The longer the water is retained behind the dam, the more sediments that will accumulate within the basin.

Costs for the construction of this option would range from $23,000 to $25,500. This does not take into account the purchasing or leasing of the land, the necessary local, state or federal permits, and consulting and environmental assessment fees. There would also be a long term cost of maintenance, and the need to occasionally remove and dispose of the accumulated sediments.

This option only treats the runoff before it enters the lake. It does not address watershed erosion, or reduce the amount of streambank erosion or scouring taking place in the three tributaries. Therefore, this alterative is not the most economical and should only be considered as a last step in a comprehensive watershed treatment plan.

Alternative #2 - Due to the erosive grades within the ditch, in-channel reconstruction should be considered to reduce the grade to a minimum of 0.4% (if armored with riprap or 0.3% natural channel). To reduce the channel grade to 0.3%, 24 feet of fall within the system must be removed. This would require six open-throated type structures, placed within the channel; only four feet of fall should be removed at a time. A benefit of these types of structures is that they may be installed so the floor of the structure can be placed at an elevation of a stable or non-erosive grade. This would allow the structure to be placed above the grade of the existing ditch. The best and most efficient time to do this work is from mid-July to September 1st, when it is typically dry and flow is low. Each structure would average $9,000, for a total project cost of $54,000. This may be the best option both economically and environmentally, because there is less need for clearing of access points, and less excavation is needed within the channel.

Alternative #3 - The installation of gabbion basket structures within the channel, similar to the one installed in the subdivision at the mouth of the Launer Ditch. These structures are labor intensive because the rocks must be placed, and the baskets tied together and shut. Six gabbion structures would be needed. Gabbion baskets would be placed up to the top of the bank, or riprap may be used to replace the gabbions on the upper half of the bank. The cost of these gabbion basket structures, installed, would be slightly higher than the cost of the existing one. The higher cost would result from the remote location of construction and installment, and the amount of clearing and excavation needed. Each gabbion structure is estimated at $16,000, for a total project cost of $96,000. This might not be the most economical option.

Alternative #4 - Rock Chute Structures in the channel. Rock chutes would require a special-ordered size riprap of 9" or 12" to withstand a 387 cubic feet per second flow that is typical in Dillion Creek. The conditions under which these types of structures are constructed are similar to the conditions of the previously mentioned gabbion baskets. These structures are also labor intensive and require additional excavating and clearing. Each structure would require 451 tons of riprap and geotextile material. The approximate cost for each structure would be $16,000, for a project total of $96,000. Like option #3, this may not be the most economical option.

Alternative #5 - Bioengineering. Though this is a viable option, cost may be a prohibiting factor. This procedure requires reshaping of the banks for a stable slope. It may, in some reaches, require the toe of the banks to be secured and stabilized with riprap or logs anchored in place. On the Williams Drain in Marion County, this approach was used on a 1/4 mile section. Jute netting, rock deflectors, and willow sprouts were used for a total construction cost of $150,000. Engineering and consulting fees also totaled $150,000. Thus an estimated cost for this alternative would be $300 per lineal foot. This would be dependent on availability of willow shoots, volunteer help, options chosen, and the consultant fees. Though cost is extremely high, small areas may benefit from this alternative if little site preparation work is needed.

There are two more tributaries that outlet into Enchanted Hills Subdivision. The Launer Ditch, just to the north of Dillon Creek, is 6000 feet long. The Norris Branch is 5000 feet long. They both have an average channel grade of 0.4%. Neither channel is as erosive as Dillon Creek, but reduction in the channel grade would reduce the streambank erosion and scouring that is occurring. Two open throat structures constructed in each channel would reduce the grade to an acceptable level. These structures would not be as large as the structures on Dillon Creek. This alternative would require four structures, combining for a total cost of $30,000 to $70,000, depending on the type of structure selected. See Table 2 for cost comparison of alternatives.

Dillon Creek:

Alternative	Description	Estimated Cost
#1*	Sediment Basin	$23,000.00 - 25,000.00
#2	Grade Stabilization Str. (Notch drop)	54,000.00
#3	Grade Stabilization Str. (Gabbian Baskets)	96,000.00
#4	Grade Stabilization Str. (Rock Chute)	96,000.00
#5	Bioengineering	300.00 LF

* Does not include the cost associated with land rights and environmental issues.

Launer and Norris Ditches:

Alternative	Description	Estimated Cost
#1	Grade Stabilization Str. (Notch Drop)	$30,000.00
#2	Grade Stabilization Str.	55,000.00
#3	Grade Stabilization Str. (Rock Chute)	55,000.00
#4	Bioengineering	300.00 LF

Table #2: Estimated Implementation Costs

All alternatives may still require the use of riprap and sediment traps. Riprap may need to be placed in slough areas or around unstable curves. An average area may be 100 to 150 feet long and require 50 to 100 tons of stone. The average cost per site would be $1,000 to $2,000. Sediment traps could be installed and be spaced every 1 1/2 miles. Locating these traps near roads or easy access points is convenient when maintenance or cleaning becomes necessary. These traps are typically 3 feet below existing ditch bottom, and are 200 to 300 feet long. Depending on site conditions, each trap could cost from $450 to $1,000.

Because Dillon Creek and Launer Ditch are county-regulated drains, the Enchanted Hills Watershed Task Force should consult with Kosciusko and Noble Counties Surveyors as they select alternatives for improvement work.

D. Enchanted Hills Lake Channels

1. Sources of Sediments

A team consisting of Don Ruesch - National Resource Conservation Service Soil Scientist, Wayne Stanger - National Resource Service Noble County, Doug Nusbaum - Indiana Department of Natural Resources Noble County, and Kent Tracey - Indiana Department of Natural Resources Lake and River Enhancement, conducted the site review. For the purpose of this study, core samples were taken at the outlet of Dillon Creek and at the outlet of Launer Ditch. Additional core samples were taken down stream from each outlet.

Core samples taken within the lake channels indicated that sediment build-up is a slow and on-going process. This is indicated by numerous storm events that are evident when examining the layers of the core samples. The largest volume of sediment is delivered from Dillon Creek. A slower build-up from the Launer Ditch is evident when examining the samples. Core samples show that from the outlet of Dillon Creek to 200 feet downstream, there is a fast accumulation of coarse sediments from the watershed, and from stream channel erosion. Stratification of sediments is occurring from 200 to 580 feet downstream of the outlet. This suggests slower accumulation. From 580 to 700 feet downstream of the outlet, very slow accumulation is occurring. This is evident from the fine silts found within the core samples. This reach also displayed a significant amount of sediment delivered from the subdivision. Core samples taken near the bridge revealed coarse sediments delivered from roads and home construction. The layers of a core sample taken 800 feet downstream showed the upper 4-6 inches were very fine silts. Six to eighteen inches was muck or the original channel bottom. At this point very little sediments were observed coming from the watershed. Most samples had 10% to 12% organic matter (% dry weight). This could be a result of fallen leaves, lawn clippings, or aquatic weed kills.

Five to six feet of channel depth is usually adequate for most water craft operation within lake channels. Shoreline stabilization, in areas where steep banks are sloughing off into the channels, will help maintain these depths along the outer edges of the channels. It may also be necessary to provide a stable outlet for surface runoff from the subdivision. This may be accomplished by small sediment traps or the use of grade stabilization structures.

2. Re-routing of Tributaries

The Re-routing or diversion of flow of the three tributaries that enter Enchanted hills Subdivision would have both positive and negative effects on the lake channels.

Positive Effects:

One benefit would result from sediment and nutrient loads not entering the channels. A reduction in sediment and nutrient loads would extend the life of the channel. In the case of an environmental accident in or around the channels, containment and clean-up would be easier. Without the flow entering the channels, flushing of the contaminants into the lake would be slower. Re-routing would also mean adding another inlet into the lake. Many people claim fishing is better near inlets to lakes. Finally, Johnson Bay is shallow, and nutrients and sediments may be utilized by the wetland plants in the area.

Negative Effects:

The re-routing of tributaries would negatively effect this natural lake in many ways. Local, state, and federal permits would be needed. There would be several hearings to attend in this process. This would result in mitigation to restore or create new wetlands to replace those that would be lost. This may result in high legal fees and land purchase costs. High water tables near lakes usually create challenges for construction work near shorelines. Costs are extremely high when considering construction in these areas, because of the methods used, and the hauling away of the spoil material. Wetland areas adjacent to the lake would be reduced, and some drainage would occur in these areas. There would be an adverse effect on the wetland ecosystems and some changes would occur. Re-routing would allow bedload nutrients and sediments to enter directly into the lake. Lastly, without a base flow (that the tributaries now provide) entering the lake channels, they may become stagnant.

E. Water Quality Test Results

Preliminary water quality data was collected by Commonwealth Biomonitoring and West Noble High School Riverwatchers. Baseline information was gathered at a Level II degree of involvement. Level II testing includes both limited water chemistry, and the collection of insects identified by family or order. Sites sampled included Dillion Creek at the county line, and at points where each of the three tributaries outlet into the lake channels. Hach chemical test kits, spectrophotomenters, kick nets, microscopes, and computer data entries were some of the tools used in gathering and processing the data.

Chemical tests, using different parameters, were taken on six different dates at all four locations. Water samples from these sites were tested for dissolved oxygen, fecal coliform, pH, temperature, phosphates, nitrates, and total suspended solids. Test results varied on each date, as expected. Variations within the tests could be attributed to watershed activities, climatic conditions, and/or the flow rate of the tributaries. Preliminary results indicated water quality within the tributaries was "good".

Continued testing under various conditions, from high flow (after a major storm event) to low flow, is recommended. The more chemical data collected and compared, the better overall indication of the water quality in the tributaries that enter the subdivision.

Biological sampling of insects in the tributaries was conducted at three different sites. For the purpose of this study insects were separated into four groups. Group 1 consisted of insects that were most intolerant to polluted waters. Examples of these are dobson fly and stone fly. They are indicators of excellent water quality. In contrast, group 4 insects are very tolerant to pollution. Examples are leeches or blood worms. When these (Group 4) are the only organisms present, they indicate poor water quality. When sampling lakes, rivers, and streams, insects from all groups may be present. This is the case in the sites that were sampled within the watershed. The presence of insects from Group 1 indicated "good" water quality within the tributaries of this watershed.

The preliminary chemical and biological test results indicate an overall rating of "good" water quality within the tributaries. However, continued testing, especially during major storm events, may reveal higher readings within some parameters of the overall water quality index. It is recommended that continued testing and monitoring be a part of any proposed watershed project.

III. SUMMARY AND RECOMMENDATIONS

To maintain and improve a healthy watershed environment, many resource needs must be addressed. To accomplish the objectives outlined in the beginning of this report, everyone in the watershed must do their part to reduce sediment loading and improve the quality of water in the channels and lake. The problems of the watershed have many causes, and effective solutions must involve many different actions, people, and disciplines.

Implementation of the recommendations in this report might seem difficult. However, if the Task Force and watershed residents continue to work as a team, through watershed planning and implementation of best management practices, the Task Force objectives will be met. It is important to remember that watershed problems did not develop over night. The solutions to these problems, as well, will not be implemented overnight. Watershed health enhancement and maintenance is an on-going process.

<u>Rural Watershed</u>:

There is a moderate potential for soil erosion on 18% of the cropland in the watershed. There are no soils which have potential for severe erosion. The adoption of conservation tillage practices is on the increase. Some needed structural practices have been implemented in the past five years.

Typically, the concern for erosion and delivery of sediment, nutrients and pesticides would be slight to moderate in a watershed with these characteristics. However, these problems may be greater than normal, due to the quick runoff response after rainfall. Ninety percent of the watershed is within 2600 feet or less of an open ditch. Recommendation: Land treatment activities should be accelerated to further reduce the delivery of sediment, pesticides, and nutrients to the tributaries.

<u>Urban Watershed</u>:

The urban development around the lake has an adverse effect on water quality, and increases the volume of sediment delivered to the channels. Erosion from construction sites and roadside ditches is a source of sediment in the channels. (This was confirmed in one of the channel core samples taken.) Pesticides and nutrients are likely entering the channels through application of lawn fertilizers, and through the use of herbicides and insecticides on lawns, trees, and shrubs. The loss of wetlands to development eliminates areas that previously filtered sediment and related pollutants.

Recommendations: The Enchanted Hills Homeowners Association should develop guidelines for: (1) controlling soil erosion within development areas, and (2) maintaining or improving existing wetlands. Field days and other educational programs should be initiated in an effort to make each homeowner aware of those best management practices they should implement.

Tributaries - Dillon Creek, Launer Ditch, and Norris Branch:

In-stream erosion appears to be a major contributor to the sediment loading in the channels. Excessive grades within the streams, combined with quick runoff from the watershed, result in higher water velocities within the streams.

Recommendations: Select one or more of the alternatives recommended, and complete the works of improvement.

Channel System:

Sedimentation build-up in the channels is most significant within the first 400-500 feet below the outlet of each tributary (especially in the Dillon Creek). Core samples taken, within the channel below Dillon Creek and Launer Ditch, indicated that sediment build-up is a slow process. Some sections of the channel do not have the 5-6 feet of depth necessary to maneuver some water craft. Core samples indicated that the depth of the original channel was approximately six feet (based on limited core samples). Channel banks are unstable in some areas, resulting in bank erosion.

Recommendations: A current inventory of water depth in the channels should be completed and compared with the most recent inventory data. Channel banks should be stabilized where most critical erosion is occurring. The speed of water craft should be limited, to avoid wave action on the banks of the channels and the stirring up of nutrients in the channel bottom. Channels should be excavated to a minimum depth of 5-6 feet to restore full recreational benefits.

Re-routing Tributaries:

It does not appear that re-routing or diverting the tributaries directly to the lake is a viable alternative. The adverse impacts outweigh the favorable effects.

In Summary:

The following sequential flow of activities is recommended for your consideration in addressing resource needs:

1. Begin planning and implementing recommendations that require minimal funds. For example: newsletters, field days, guidelines for development, etc.

2. Initiate a land treatment program in the rural portion of the watershed.

3. Address the tributary problems.

4. Reconstruct channels to minimum depth and complete other related works of improvements.

IV. POTENTIAL FUNDING SOURCES

The costs associated with the technologies discussed in the preceding sections are frequently beyond the financial resources of small communities, such as that within the Enchanted Hills Watershed. There are some available mechanisms for small communities to obtain funding for these types of activities.

The U.S. Environmental Protection Agency funds a limited number of lake restoration projects through the Clean Lakes Program. Details can be obtained through the Indiana Department of Environmental Management office in Indianapolis, IN.

The IDNR Division of Soil Conservation, Lake and River Enhancement (LARE) program may fund construction actions up to $100,000.00 for a specific project, or $300,000.00 for all projects on a specific lake or stream. It also will cost-share approved watershed land treatment practices up to eighty percent. The program does not provide funding assistance for such efforts as: control of aquatic weeds, algae, etc., with pesticides; building of sea walls, piers, boat ramps, etc., removal of sediment (i.e., dredging, ditch reconstruction); or water/sewer service to lake residents. For more information contact your local Soil and Water Conservation District, or the IDNR Division of Soil Conservation, 402 West Washington Street, Indianapolis IN, 46204, 317-233-3870.

Other sources of funding might include grants through private foundations, trusts, etc. Some Lake Associations have initiated conservation/water quality special funds through homeowner assessments. These funds are used to provide financial incentives for planning and implementing those best management practices required to maintain and improve the health of the lake and its environment.

V. SOURCES

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